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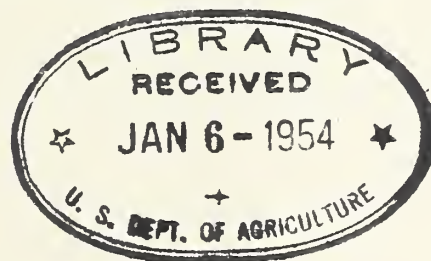
WALLA WALLA RIVER AND TRIBUTARIES  
SURVEY REPORT

WALLA WALLA RIVER WATERSHED

WASHINGTON AND OREGON

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Program for Runoff and Waterflow Retardation  
and Soil Erosion Prevention



Pursuant to the Act approved June 22, 1936  
(49 Stat. 1570) as amended and supplemented

October 1950  
(Revised June 1953)



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## INTRODUCTION

Authority. This survey report is submitted under the provisions of the Act approved June 22, 1936 (49 Stat. 1570) as amended and supplemented.

Scope. This report outlines a program of watershed treatment for runoff and waterflow retardation and soil erosion prevention needed in the Walla Walla River Watershed in Washington and Oregon. The Walla Walla River Watershed contains approximately 1,800 square miles or 1,152,000 acres, of which approximately two-thirds lies in Washington and one-third in Oregon (Map 1).

The watershed program is composed of two groups of measures. One group consists of measures primarily for flood prevention, hereinafter called flood prevention measures (A measures), which are not now normally being installed under existing authorities for current national programs of the Department of Agriculture. The other group consists of measures used for the conservation of watershed lands which contribute directly to flood prevention, hereinafter called land treatment measures (B measures), and which are being installed under existing authorities for such programs.

This report presents recommendations for authorization of the flood prevention measures under the Flood Control Act of June 22, 1936, as amended and supplemented, and for the installation of the land treatment measures under existing authorities concurrently with the flood prevention measures.



Need for the Watershed Program. The program recommended in this report affects approximately 60,000 people, of whom well over half live in the towns and villages, all of which are located in the stream valleys. Periodic floods resulting from snow melt and rain, or cloudburst type summer storms, cause measurable losses of approximately \$500,000 annually. In addition irreparable losses result from serious erosion of the highly productive croplands. If other losses such as dislocations which result from floods, loss of labor, interruption of school, lack of a stable farm income, and mental anguish caused by floods, could be measured in dollars and cents they would probably exceed the measurable losses.

Six towns and a number of villages are subject to periodic damage from flooding, as is the greater part of the highly productive irrigated land, much of which is used for truck crop production. High annual erosion rates cause widespread sediment damages to roads, railroads, and irrigation canals. Sediment damage amounts to \$134,000 annually.

#### RECOMMENDATIONS

It is recommended that:

(a) The Secretary of Agriculture be authorized to install the flood prevention measures on a cost-sharing basis 1/ with local interests during a 20-year period in the Walla Walla River Watershed in

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1/ The share of the cost to be borne by local interests may consist of cash, labor, materials, equipment, land, easements, rights-of-way and other contributions.



Washington and Oregon under the provisions of the Act of June 22, 1936, as amended and supplemented, at an estimated Federal cost of \$5,681,400.

(b) The land treatment measures, for which no additional authority is requested herein, be applied under existing authorities concurrently with the installation of the flood prevention measures to assure the proper functioning of the program.

(c) As a condition precedent to the installation of the program, cooperating state and local agencies be required to furnish assurances satisfactory to the Secretary of Agriculture with respect to their ability to operate and maintain the flood prevention measures on non-Federal land.

(d) The authority of the Secretary of Agriculture to carry out the flood prevention measures be supplemental to all other authority vested in him, and that nothing in this report shall be construed to limit the exercise of powers heretofore or hereafter conferred on him by law to carry out such measures or other measures that are similar or related thereto.

(e) The Secretary of Agriculture be authorized to construct such buildings and other improvements as are needed to carry out the flood prevention measures.





## DESCRIPTION OF WATERSHED

The watershed of the Walla Walla River, a tributary of the Columbia River, has an area of approximately 1,800 square miles. It is located in southeastern Washington and northeastern Oregon. Elevations range from 300 feet at the mouth of the Walla Walla River to 6,000 feet at its source.

The Walla Walla River and its principal tributaries rise in the rugged Blue Mountains in the eastern part of the watershed and flow in a westerly direction, joining the Columbia River near Wallula, Washington. The principal streams of the watershed are the Walla Walla River with its North and South Forks above Milton-Freewater, Oregon; Mill Creek, which flows through the city of Walla Walla, Washington; and the Touchet River which flows through the towns of Dayton, Waitsburg, and Prescott, Washington.

The Walla Walla River and, to a lesser extent, Mill Creek, have aggrading and poorly defined channels in the lower valley. Tributary streams, many of which originate below the mountains, have degrading channels.

The climate of the watershed is characterized by hot, dry summers, and moderately cold, wet winters. The average annual precipitation varies from less than 10 inches in the west to over 40 inches in the mountains. About 75 percent of the annual precipitation, much of which is snow, occurs between November and May. Temperatures vary from over 100° F in the summer to much below zero in the winter. Average temperatures, however, are relatively mild.





Settlement began in the watershed in 1843. Agricultural development was rapid during the decade 1860 to 1870. The population remained relatively stable until the war years and immediately thereafter, when it increased materially. The greater part of the watershed's population of over 60,000 is located in the towns and villages. The agricultural portion of the watershed is well served with highways, farm to market roads, railroads, airlines, telephones and electricity.

The eastern portion of the watershed is rugged mountains with deeply incised streams of high gradient and steep canyon slopes. Grass, brush and forests are the dominant types of cover. Approximately 156 square miles are a part of the Umatilla National Forest.

The major portion of the watershed is devoted to agricultural use. It is part of the Columbia Plateau which is dissected by many small streams. Well-rounded hills with long steep slopes are characteristic. The soils are deep and friable and are subject to serious erosion. The predominant type of agriculture is wheat, dry pea or peas for canning, production. Farm units in the dry land section are large, averaging about a section in size. Approximately 35,000 acres of the valley lands are irrigated and devoted to diversified, highly-intensified types of farming. The principal irrigated crops are vegetables, plants for transplanting, berries, fruits, commercial hay and pasture.

#### FLOOD PROBLEMS

Flood problems of the Walla Walla River watershed are of three distinct types:



1. Main Stream Floods. Damaging floods along the main stream and major tributaries occur with a frequency of once in 3 to 5 years. Floods of disastrous magnitude occur about once in 25 years. The floods of 1882, 1906, and 1931, were of this magnitude.

Floods on the main stream and major tributaries originate in the mountainous eastern section of the watershed from winter and spring storms of wide areal extent, several days duration, and low precipitation intensity. Runoff from such storms is augmented by rapid snow melt caused by warm "chinook" winds associated with the storms. Runoff may also, at times, be increased by frozen soils and ice sheets below the snowpack.

Damages from floods on the main streams and major tributaries are largely concentrated along the lower reaches, from the foothills to the Columbia River. Damages in these areas are closely related to stages or magnitudes of the floods. The valleys along the lower reaches of the streams generally have highly developed urban areas; intensively farmed irrigated lands; and a network of highways, roads, railroads and public utilities. Principal damages are to property, roads, railroads, crops, and land loss.

2. Local Floods on Tributary Streams in Agricultural Areas. Winter and spring floods occur in much of the agricultural area one or more times annually. The severity and frequency of such floods increases from the drier western to the more humid eastern parts of the agricultural area in the mountain foothills. Such floods are local in nature and generally have little affect on flood regimens of the main stream or major tributaries.



Such floods originate from low intensity rainfall over the agricultural area during storms of several days' duration and wide areal extent. Runoff, sediment production and erosion are often increased by frozen soils and snow melt. Primary factors involved are cultural practices of "black" fallow and seeding spring wheat in the late fall on the "black" fallowed lands. Both practices leave the soil virtually unprotected during the winter and early spring months.

Damages from the winter and spring floods occur throughout the agricultural area. They consist principally of sedimentation damages to highways, roads, railroads, crops, land and irrigation systems and improvements; land and crop destruction along the small streams and small watercourses; damages to roads, bridges, culverts, fences and buildings along the small streams; and extremely serious damage to land and crops by erosion in the fields.

3. Summer Flash Floods. Summer flash floods occur throughout the watershed as a result of intense convection (cloudburst) type storms of small areal extent and short duration. Floods of this nature are local and erratic in occurrence and do not affect the flood regimen of the main streams. One or more generally occur each year somewhere in the watershed, but generally do not occur at any given point more frequently than once in 7 to 10 years.

Flood damages from this type of storm are dependent on place of occurrence. If they occur in agricultural or urban areas they cause extensive damage to buildings, roads, railroads, bridges, crops, livestock, land, equipment and irrigation systems. If in the mountain areas,





relatively little damage is caused. These floods are erratic in occurrence and nature and are unpredictable in frequency or location. Because of this, damages caused by such floods are not included in the damages listed in the report.

Other flood damages which were considered but not evaluated include loss of life, personal injuries, disruption of traffic and public services, insecurity due to flood hazard and costs of relief and rehabilitation.

Table 1 lists the monetary evaluation of the average annual flood-water and sediment damages.

#### ACTIVITIES RELATED TO FLOOD CONTROL

The survey report for the Walla Walla and Touchet Rivers and Mill Creek, prepared by the Department of the Army, Corps of Engineers, (House Document 578, 75th Congress, 3rd Session and House Documents 662 and 719, 76th Congress, 3rd Session) and authorized by Congress includes numerous improvements for flood protection. The proposals of the Corps of Engineers for control of floods in the watershed as described in House Document 308, 60th Congress, 1st Session and House Document 578, 75th Congress, 3rd Session are reviewed in a Review Report of the Columbia River and tributaries, 1949. Further control work on selected main stream reaches were authorized by Congress in Public Law 516, 81st Congress, 2nd Session, substantially in accordance with recommendations contained in the Review Report. Several of the authorized structures have been completed or are under construction. In the development of the recommended program for the Walla Walla





Table 1

## ESTIMATED AVERAGE ANNUAL DAMAGE

Walla Walla River Watershed  
(Long-term projected prices)

Type of Damage	Average Annual Damage	
<u>FLOODWATER DAMAGE</u>	<u>Dollars</u>	
<u>Agricultural and Non-Agricultural</u>		
Crops and pasture	133,700	
Other Agricultural	36,400	
Non-Agricultural	38,100	208,200
<u>Land</u>		
Land loss by bank cutting	72,500	
Land Loss by scouring	1,500	74,000
<u>SEDIMENT DAMAGES</u>		
Crop loss by deposition	3,900	
Roads, railroads, and irrigation systems	130,100	134,000
<u>INDIRECT DAMAGES</u>		77,100
TOTAL AVERAGE ANNUAL DAMAGES		493,300



River watershed, the Department of Agriculture has given full consideration to all areas protected by existing or authorized works of the Department of the Army, and no flood control benefits are claimed in such areas.

The Department of Agriculture, through its several agencies and in cooperation with State and local agencies, is currently assisting owners and operators of farm, ranch and forest land in the application of measures which are deemed of primary importance to the objectives of the Flood Control Act. On forest land or on land being converted to woodland these measures include tree plantings and protection of stands of timber against damage by fire and by the grazing of livestock. On grassland or on land being converted from cropland to grassland these measures include seeding, fencing, spring and well development, control of grazing; eradication of brush and weeds and fire protection. Measures being installed on cropland include terraces, field diversions, establishment of farm and group waterways, grade stabilizing and waterflow control structures, proper crop rotations, crop residue management, strip cropping and contour farming. The Forest Service administers approximately 1,056,000 acres of forest land in the Umatilla National Forest and cooperates with the states in providing fire control for about 213,000 acres of private woodland.

The two states in the watershed operate through several of their departments and institutions to provide valuable conservation service to farmers, ranchers, municipalities and industries. These include research and the dissemination of research findings and educational



activities. Soil conservation districts, drainage and irrigation districts, and other similar organizations perform valuable functions in the management and use of soil and water resources. Local interests have organized and have constructed works of improvement on several of the main streams or tributaries. Map 2 shows the location of existing, authorized or proposed works of other Federal, state or local agencies.

### RECOMMENDED PROGRAM

The program recommended in this report is designed to meet the needs of the Walla Walla River Watershed for runoff and waterflow retardation and soil erosion prevention. It consists of two groups of interrelated measures, which are designated as flood prevention measures (A Measures), and land treatment measures (B Measures).

The flood prevention measures were developed by studying representative sample areas to determine the types and quantities of measures needed and their economic feasibility. These studies assumed that the land treatment measures would be installed at a comparable rate with the installation of the flood prevention measures in order to complete the watershed program within a period of 20 years and achieve the benefits estimated in this report. A detailed study was made of the present condition of the sample watershed land and stream courses to develop the most effective means for reducing floodwater and sediment damages. The land treatment measures were developed on the basis that they would be complementary to and would be carried out concurrently with the installation of the flood prevention measures.





Various combinations of measures were considered in determining the most effective and economical program for alleviating agricultural flood damage in the tributaries of the Walla Walla River Watershed. The total program for the watershed was largely derived by expanding the program developed for the sample areas to the entire watershed area.

The recommended flood prevention and land treatment measures are described in the following section of the report.

### FLOOD PREVENTION MEASURES (A Measures)

#### Floodwater Retarding Structures

Twenty-nine floodwater retarding structures will be constructed in strategic locations on tributary streams. Drainage areas above individual dams will vary from 4 to about 12 square miles.

The small detention dams will be constructed of rolled earth fills with vegetated or concrete lined emergency spillways. They will have outlet conduits to provide safe outlet for floodwaters, and in addition provide an outlet which can be used to release all or most of the storage.

These structures will be so located and correlated with other measures that a high degree of protection will be afforded to areas below them.

#### Stabilizing and Sediment Control Structures

Seven hundred and twenty-nine permanent and 883 semipermanent stabilization and sediment control structures will be constructed in field farm and subwatershed waterways. Such structures will be





constructed with masonry concrete or steel for the permanent structures and may be wire-bound loose rock, or logs for the smaller, semipermanent structures. The structures will consist of such items as cross stream structures, drop spillways, drop inlets, desilting basins, chutes and establishment of vegetation and construction of fencing, all used in various combinations.

#### Subwatershed Waterway Improvement

Sixteen hundred miles of larger subwatershed waterways which require community action for their control or protection will be improved or stabilized. Control will be accomplished by a combination of stabilization structures, bank sloping or shaping and seeding or planting. Stabilization of such waterways is a key to erosion control of field or farm drains and diversion terraces.

#### Stream Channel Improvement

In order to prevent land loss and prevent degradation of stream channels about 302 miles of tributary stream channels will be improved or stabilized. This will be accomplished by protective or improvement works such as riprap, check dams, channel straightening and sloping, bank planting or seeding and other complementary measures.

#### Cooperative Fire Protection

Approximately 66,800 acres of privately owned forest land lying outside of existing protection districts and receiving no organized fire protection under the going program will be brought under organized protection. The improvement in the vegetative cover resulting from this protection will improve and maintain at



a high level soil conditions which will reduce soil erosion and increase infiltration rates and detention storage capacities.

## LAND TREATMENT MEASURES (B Measures)

### Terraces and Field Diversions

To provide erosion control on long, steep slopes, about 1200 miles of terraces and field diversions will be installed. These structures, when installed, will break the length of slope and will divert runoff to improved waterways.

### Farm Waterways

In order to provide safe outlets for terraces and field diversions, diversion terraces and natural field drainage, about 1790 miles of farm waterways will be stabilized or improved. This will be accomplished by sloping, plowing in, seeding, and installation of necessary structural measures, such as temporary check dams, and outlets or drop structures.

### Erosion Control Structures

About 2500 permanent and 5000 semipermanent erosion control dams and structures will be built in field, farm and minor sub-waterways to support and complement vegetation of such waterways. Most waterways will require one or more such structures at critical points for their stabilization. These structures will be concrete, masonry, sheet metal, wire-bound loose rock, treated lumber, logs, etc.

### Diversion Terraces

Broadbased diversion terraces or dikes are required to supplement the terraces and field diversions. Seven hundred and five



miles of such terraces will be required to intercept runoff from overlying fields and to protect critically eroding areas.

#### Green Manuring

Green manuring in the form of legumes or grass is required to protect fields which are subject to serious erosion. About 552,000 acres of land will be seeded to green manure crops in the proper sequence in crop rotation.

#### Subsoiling

Subsoiling will be practiced on 294,000 acres to break up hardpan or plow sole or to provide surface protection when crop residues are lacking or additional surface protection is otherwise required.

#### Rotary Subsoiling

Rotary subsoiling will be practiced on 330,000 acres of cropland to provide increased surface storage of water and to increase infiltration.

#### Range Reseeding

About 24,500 acres of range with depleted cover or inferior grasses will be reseeded to improved grasses.

#### Grazing Management

Proper grazing management will be practiced on 146,600 acres of range. Practices to be included are noxious weed eradication, proper rotation, etc.

#### Seeding Cropland to Grasses and Legumes

About 170,000 acres of land now being cultivated is too steep, thin, or otherwise limited or hazardous for continued cultivation.





This land is eroding rapidly and is one of the primary sources of sediment in the watershed. This acreage will be seeded to improved grasses or legumes and retired from annual cultivation.

#### Fencing

Approximately 785 miles of drift or exclusion fencing will be constructed to provide better control and distribution of livestock or to protect newly seeded areas.

#### Spring Development

Three hundred and fifty-three springs will be developed in strategic locations to provide livestock water and to permit better utilization of rangeland.

#### Stock Ponds and Wells

About 260 stock ponds and 110 stock wells will be developed where springs are not available.

#### Firebreaks

About 155 miles of firebreaks will be built to prevent spread of fires in range land.

#### Tree Planting

About 7560 acres of privately-owned poorly stocked woodland and openland to be converted to woodland, and 950 acres of Federally-owned land will be revegetated by planting to forest trees. These plantations will be given adequate protection from fire and livestock grazing, and will be managed for watershed purposes with full recognition being given to flood prevention, timber and other values. The cost of this tree planting will be in addition to regular agency activities.





## Woodland Improvement

Woodland improvement practices will be followed on about 156,000 acres of privately-owned woodland and 5,700 acres of Federally-owned land. Aimed at achieving an optimum balance between watershed protection and the economic use of forest products, these practices include such measures as protection of the forest soil from unnecessary logging damage, selective cutting, and protection from grazing. The cost of installing and maintaining this measure will be in addition to regular agency activities.

### Technical Services - Openland

Technical services will be made available for planning and applying the necessary land use adjustments, for planning and applying conservation measures on cropland, rangeland and forest land, and for integrating these measures with other measures in the recommended program.

### Technical Services - Woodland

Technical services will be provided the private woodland owners for planning and applying the forestry measures such as protection from fire, grazing, overcutting, damaging logging, insects, and disease; tree planting and improvement cuttings; harvesting and marketing timber crops; and integrating specific measures with other phases of the recommended program. The cost of providing and maintaining these services will be in addition to that for regular agency activities.



## Educational Assistance

Educational Assistance will be provided relative to the need, purposes, and objectives of the program. Intensified educational efforts will be directed toward familiarizing farmers and ranchers with the specific practices essential to waterflow retardation and prevention of soil erosion.

## COST OF RECOMMENDED PROGRAM

The estimated cost of installing both the flood prevention and land treatment measures is \$18,204,700. It is estimated that local interests will provide 58.1 percent of the cost of installing these measures on non-Federal land, however, the allocation of Federal and non-Federal costs will vary by types of measures. The cost of installing land treatment measures will generally be borne in large part by individual landowners and operators since a large part of the benefit will accrue directly to the land on which the measures are applied. Flood prevention measures, however, produce public benefits often of a dispersed nature, and extending far downstream. The Federal Government will install these latter measures on non-Federal land on a cost-sharing basis and will provide a larger share of the cost of installation than in the case of land treatment measures. The cost of installing, operating, and maintaining the land treatment measures on Federal land will be borne by the agencies responsible for the administration of such land.



## FLOOD PREVENTION MEASURES (A Measures)

The estimated cost of installing the flood prevention measures is \$7,654,000 (See Table 2). Of this cost it is estimated that the Federal Government will expend \$5,681,400 and local interests \$1,972,600.

Local interests will be required to furnish without cost to the Federal Government all land, easements, and rights-of-way needed in connection with the installation of the flood prevention measures; and will be expected to make any additional contributions that may be necessary to meet their proportionate share of the cost of installing these measures as determined by the Secretary of Agriculture to be equitable in consideration of the anticipated benefits from such measures.

The estimated annual cost of operating and maintaining these measures is \$161,400, of which \$1,500 will be borne by the Federal Government for cooperative fire protection and \$159,900 will be borne by local interests.

## LAND TREATMENT MEASURES (B Measures)

The estimated cost of installing the land treatment measures is \$10,540,600 (See Table 3). Of this cost, it is estimated that the Federal Government will expend \$107,400 on Federal land and \$1,833,400 on non-Federal land; and that local interests will expend \$8,599,800 on non-Federal land. The estimated Federal cost of these





Table 2

ESTIMATED COST OF INSTALLING FLOOD PREVENTION MEASURES  
(A Measures)

Walla Walla River Watershed  
(Long-term projected prices)

Measure	Unit	Quantity	C O S T		Total
			Federal	Non-Federal	
			(dollars)	(dollars)	(dollars)
Floodwater retarding structures	Each	29	1,884,600	601,500	2,486,100
Stabilizing and sediment control structures	Each	1,612	2,425,300	781,800	3,207,100
Subwatershed waterway improvement	Mile	1,600	838,800	407,400	1,246,200
Stream channel improvement	Mile	302	505,600	161,900	667,500
Cooperative fire protection	Acre	66,880	27,100	20,000	47,100
Total			5,681,400 <sup>1/</sup>	1,972,600	7,654,000

<sup>1/</sup> Federal program costs include a sum of \$200,000 for hydrologic evaluation and collection of basic data during period of program installation.





Table 3

ESTIMATED COST OF INSTALLING LAND TREATMENT MEASURES  
(B Measures)

Walla Walla River Watershed  
(Long-term projected prices)

Measure	Unit	Quantity	C O S T		
			Federal	Non-Federal	Total
			(dollars)	(dollars)	(dollars)
Terraces & field diversions	Mile	1,200		226,800	226,800
Farm Waterways	Mile	1,790		241,600	241,600
Erosion control structures	Each	7,500		1,339,000	1,339,000
Diversion terraces	Mile	705		183,000	183,000
Green Manuring	Acre	552,000		1,518,000	1,518,000
Subsoiling	Acre	294,000		1,375,900	1,375,900
Rotary Subsoiling	Acre	330,000		330,000	330,000
Range reseeding					
Federal land	Acre	4,000	44,200		44,200
Non-Federal land	Acre	20,500		129,200	129,200
Grazing Management	Acre	146,600		65,900	65,900
Seeding cropland to grasses & legumes	Acre	170,000		1,683,000	1,683,000
Fencing					
Federal land	Mile	20	14,700		14,700
Non-Federal land	Mile	745		375,400	375,400
Spring development					
Federal land	Each	48	26,600		26,600
Non-Federal land	Each	305		109,800	109,800
Stock ponds & wells	Each	370		408,600	408,600
Firebreaks	Mile	155		2,500	2,500
Tree planting					
Federal land	Acre	950	15,800		15,800
Non-Federal land	Acre	7,560	21,600	154,800	176,400
Woodland improvement					
Federal land	Acre	5,700	6,100		6,100
Non-Federal land	Acre	156,000		28,100	28,100
Technical Services - openland			1,342,000		1,342,000
Technical Services - woodland			163,200	121,600	284,800
Educational assistance			306,600	306,600	613,200
Subtotal - Federal land			107,400		107,400
Subtotal - Non-Federal land			1,833,400	8,599,800	10,433,200
Total			1,940,800	8,599,800	10,540,600



measures on non-Federal land does not include financial assistance by the Federal Government, such as agricultural conservation payments to landowners and operators. Any assistance of this kind that may be provided at the time of program installation will help landowners and operators to meet their share of the cost.

The estimated annual cost of operating and maintaining these measures is \$599,100. Of this amount, it is estimated that the Federal Government will expend \$2,600 on Federal land and \$15,000 for technical services on non-Federal woodland and that local interests will expend \$581,500 on non-Federal land.

#### BENEFITS FROM THE RECOMMENDED PROGRAM

The recommended program will reduce floodwater and sediment damages and increase production. It is estimated that the program will reduce floodwater damage to crops, grassland and other agricultural and non-agricultural property by approximately 84 percent, floodwater damage to land by approximately 73 percent, sediment damage by approximately 78 percent and indirect damage by 80 percent. Other benefits will accrue from more intensive use of flood plain land made possible by elimination of numerous small floods. The floodwater retarding structures will provide incidental irrigation and water conservation benefits. Benefits in the form of increased crop, grassland and forest land yields will result from the installation of the land treatment measures.



The full attainment of the benefit evaluated in this report is dependent upon the cooperation and support of owners and operators and local agencies in installing and maintaining the recommended measures.

The estimated average annual benefit resulting from the recommended program for the Walla Walla River Watershed is shown in Table 4.

In addition to the monetary benefit, there will be unevaluated benefits such as the reduction of loss of life and alleviation of illness, hardship and disease epidemics following flood disasters; increased food and shelter for wild fowl and game animals; and improved recreational facilities.

#### COMPARISON OF BENEFIT AND COST

The ratio of the average annual benefit of \$1,783,500 to the estimated average annual value of the total cost of \$1,337,700 of the recommended program is 1.33 to 1. This ratio has been computed on the basis of long-term projected prices.





Table 4

## ESTIMATED AVERAGE ANNUAL BENEFITS FROM THE RECOMMENDED PROGRAM

Walla Walla River Watershed  
(Long-term projected prices)

Source	Average Annual Benefits
	(Dollars)
Reduction of Floodwater Damages	174,200
Reduction of Land Loss	54,300
Reduction of Sediment Damages	104,800
Reduction of Indirect Damages	62,100
Water Conservation Benefits	19,400
Irrigation Benefits	71,700
Conservation Benefits	
Cropland	1,113,400
Rangeland	157,900
Forestland	25,700
Total Program Benefits	1,783,500





